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(54) **Process for fixing a tubular reinforcing insert to a tubular metal structure and apparatus for carrying out the process**

Verfahren zur Befestigung eines rohrförmigen Verstärkungseinsatzes in eine metallische rohrförmige Struktur und Vorrichtung zur Anwendung des Verfahrens

Procédé de fixation d'un insert tubulaire de renforcement dans une structure métallique tubulaire et dispositif d'utilisation du procédé

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## Description

The present invention relates to a process and to an apparatus for fixing a tubular reinforcing insert to a tubular metal structure.

EP-A-0 293 101 discloses a method of making a rigid angled joint between a first length of metal tubing and a second length. This method comprises the steps of first applying a rotating piercing tool under pressure to the first tube's wall. The tool thus forms a hole surrounded by an integral bush, which is formed from the displaced tube wall material and has a diameter to closely fit the external diameter of the second tube. The second tube is inserted through the bush into the interior of the first tube and is secured therein by a bolt or screw.

In the field of motor-vehicle construction, the tubular structure may be the chassis of the motor vehicle, the support frame for the engine or a supporting structure in general. At present, when it is necessary to fix a reinforcing insert to the tubular structure at right angles thereto, a welding technique is used. The reinforcing insert serves as an anchorage for mechanical parts. For example, in the case of engine support frames, the reinforcing insert serves as the seat for vibration-damping supports and is subject to traction or axial-compressive stresses and/or shear forces.

The object of the present invention is to provide a different system for fixing the reinforcing insert so as to avoid welding and screwing.

According to the present invention this object is achieved by means of a process which includes the steps of:

- forming a hole in the wall of the tubular structure by inward deformation of a portion of the wall so that the deformed wall portion forms an annular collar,
- force fitting an end portion of the tubular insert into the said collar, and
- introducing liquid at high pressure into the tubular structure so as to compress the collar against the end portion of the tubular insert.

This technique involves a considerable reduction in the working time compared with normal fixing by welding. Moreover, if the number of reinforcing inserts to be fixed to the main structure is increased, the working time remains constant in that the operation is carried out in a single forming tool. On the contrary, when inserts are fixed by welding, the working time increases proportionally with the number of pieces to be welded.

The joint obtained by the process of the invention has greater resistance to shear forces by virtue of the greater resistant surface offered by the collar formed in the wall of the tubular structure. The dimensions of the joint are also more precise than in traditional fixing by welding.

The object of the present invention is also achieved by means of an apparatus according to claim 7.

Further characteristics and advantages of the present invention will become clear during the detailed description which follows, provided purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a schematic section of apparatus for carrying out a process according to the invention, Figure 2 is a view of the part indicated by the arrow II in Figure 1, in greater detail, Figures 3, 4 and 5 are schematic illustrations of different steps in the process of the invention, and Figure 6 illustrates a piece obtained by the process of the invention.

With reference to the drawings, a tubular structure is indicated 10 to which a tubular reinforcing insert 12 is to be fixed.

Two dies, one movable relative to the other, are indicated 14 and 16 and are adapted to clamp the tubular structure 10 between them. The die 14, 16 have respective seats 18, 20 which together form a deformation chamber. The lower die 16 has a recess 22 from the base wall of which projects a cylindrical punch 24 which, in use, extends perpendicular to the axis of the tubular structure 10. The diameter of the punch 24 is substantially equal to the internal diameter of the reinforcing insert 12 so that the latter may be fitted onto the punch 24 without forcing. As is seen in particular in Figure 2, the diameter of the recess 22 is slightly greater than the outer diameter of the insert 12. Thus the insert fitted onto the punch 24 bears against the base wall of the recess 22. The punch 24 has a pointed part which projects beyond the corresponding end of the reinforcing insert 12. The insert 12 has a conical end portion 26 ending with an annular groove 28.

In order to fit the insert 12 to the tubular structure 10, one proceeds as follows.

The structure 10 is disposed between the two dies 14, 16 and is connected to a hydraulic circuit (not illustrated) which directs high pressure fluid into the tubular structure 10. This forming technique is known per se and is generally termed "hydroforming". As a result of the forcing of pressurised fluid into the structure 10, the portion of the structure which is located in the deformation chamber 18, 20 expands radially until it is brought into contact with the walls of the seats 18, 20 which form the deformation chamber.

During the radial expansion of the wall of the tubular structure 10, the punch 24 opens a hole 30 in the wall 10 (Figure 3) causing inward deformation of a wall portion 32 which constitutes an annular collar. With the progressive radial expansion of the wall of the tubular structure 10, the reinforcing insert 12 is inserted forcibly into the annular collar 32 (Figure 4). The pressurised fluid acting in the structure 10 compresses the collar 32 against the outer wall of the insert 12 and clamps the collar 32 against the groove 28 and the end portion 26 of the insert 12.

Subsequently, the pressure of the fluid in the structure 10 is lowered and the liquid is withdrawn from the structure. Figures 5 and 6 illustrate the structure 10 after the fixing of the insert 12 in the manner described above.

#### Claims

1. A process for fixing a tubular reinforcing insert (12) to a tubular metal structure (10) comprising

forming a hole (30) in the wall of the tubular structure (10) by inward deformation of a portion of the wall so that the deformed wall portion forms an annular collar (32), characterised in that it includes the following steps:

- force fitting an end portion (26) of the tubular insert (12) into the said collar (32), and
- introducing liquid at high pressure into the tubular structure (10) so as to compress the collar against the end portion (26) of the tubular insert (12).

2. A process according to Claim 1, characterised in that the hole (30) and the collar (32) are formed by the force insertion of a punch (24) into the wall of the tubular structure (10).

3. A process according to claim 2, characterised in that it further includes the step of radially expanding a portion of the tubular structure (10) in correspondence with the anchoring point for the insert (12) due to the effect of the introduction of pressurised liquid into the tubular structure (10), the insertion of the punch (24) into the wall of the tubular structure (10) being caused by the radial expansion of the wall.

4. A process according to Claim 2 or Claim 3, characterised in that the tubular insert (12) is located on the punch (24) before the step of insertion of the punch (24) into the wall of the tubular structure (10), the punch (24) having a pointed end which projects beyond the end of the insert (12).

5. A process according to Claim 1, characterised in that the said end portion (26) of the insert (12) is conical.

6. A process according to Claim 1, characterised in that the tubular insert (12) has an annular groove (28) over which the collar (32) is closed during its compression against the end portion (26) of the insert (12).

7. Apparatus for fixing a tubular reinforcing insert (12) to a tubular metal structure (10), wherein:

a) the apparatus comprises a pair of dies (14,

16) suitable for clamping the tubular structure (10) between them;

b) one of the dies (16) has a recess (22) in its base wall, a punch (24) being fixed in the recess (22) with its free end projecting beyond the base wall, a cylindrical cavity suitable for accommodating the reinforcing insert (12) being defined between the punch (24) and the wall of the recess (22);

c) the punch (24) includes a pointed part at its free end, the point part being suitable for opening a hole (30) in the wall of the tubular structure (10) and inwardly deforming the wall portion opened when the punch (24) and the wall are moved relatively towards each other, the punch (24) being so shaped, that during continued relative movement between the punch (24) and the wall, the material around the hole (30) is progressively expanded in radial direction into an annular collar; and that d) the apparatus comprises means for introducing liquid at high pressure into the tubular structure (10).

8. Apparatus according to Claim 7, characterised in that the dies (14, 16) define a deformation chamber (18, 20) with larger dimensions than those of the corresponding portion of the tubular structure (10) before the introduction of the pressurised liquid into the structure itself so that the introduction of the liquid into the tubular structure causes the radial expansion of the portion of this structure within this chamber (18, 20) and the penetration of the punch (24) into the wall of the structure (10).

#### Patentansprüche

1. Verfahren zur Befestigung eines rohrförmigen Verstärkungseinsatzes (12) an einem rohrförmigen Teil (10), umfassend:

Formen eines Loches (30) in der Wand des rohrförmigen Teiles (10) durch Verformen eines Wandabschnittes nach innen, so daß der verformte Wandabschnitt einen ringförmigen Kragen (32) bildet, dadurch gekennzeichnet, daß es die folgenden Schritte umfaßt:

- Einpressen eines Endabschnittes (26) des rohrförmigen Einsatzes (12) in den Kragen (32), und
- Einführen von Flüssigkeit unter hohem Druck in den ringförmigen Teil (10), um den Kragen gegen den Endabschnitt (26) des rohrförmigen Einsatzes (12) zu drücken.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Loch (30) und der Kragen (32) durch

Eindrücken eines Stempels (24) in die Wand des rohrförmigen Teiles (10) gebildet werden.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß es als weiteren Schritt umfaßt: Radiales Dehnen eines Abschnittes des rohrförmigen Teiles (10) entsprechend dem Befestigungspunkt für den Einsatz (12) unter der Wirkung von in den rohrförmigen Teil (10) eingeführter Druckflüssigkeit, wobei das Eindrücken des Stempels (24) in die Wand des rohrförmigen Teiles (10) durch das radiale Dehnen der Wand bewirkt wird. 5
4. Verfahren nach Anspruch 2 oder Anspruch 3, dadurch gekennzeichnet, daß der rohrförmige Einsatz (12) vor dem Eindrücken des Stempels (24) in die Wand des rohrförmigen Teiles (10) auf dem Stempel (24) angeordnet wird, wobei der Stempel (24) ein spitzes Ende hat, welches sich über das Ende des Einsatzes (12) hinaus erstreckt. 10
5. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Endabschnitt (26) des Einsatzes (12) konisch ist. 15
6. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der rohrförmige Einsatz (12) eine ringförmige Nut (28) hat, welche vom Kragen (32) geschlossen wird, während er gegen den Endabschnitt (26) des Einsatzes (12) gedrückt wird. 20
7. Vorrichtung zur Befestigung eines rohrförmigen Verstärkungseinsatzes (12) an einem rohrförmigen Metallteil (10), worin 25
  - a) die Vorrichtung ein Paar Haltebacken (14, 16) zum Einklemmen des rohrförmigen Teiles (10) umfaßt;
  - b) einer der Haltebacken (16) eine Ausnehmung (22) in seiner unteren Wand aufweist, wobei ein Stempel (24) in der Ausnehmung (22) so fixiert ist, daß sein freies Ende über die untere Wand vorsteht, und ein zylindrischer Hohlraum für die Aufnahme des Verstärkungseinsatzes (12) zwischen dem Stempel (24) und der Wand der Ausnehmung (22) gebildet ist;
  - c) der Stempel (24) einen spitzen Teil an seinem freien Ende aufweist, wobei der spitze Teil geeignet ist, ein Loch (30) in die Wand des rohrförmigen Teiles (10) zu stoßen und den durchstoßenen Wandabschnitt nach innen zu verformen, wenn der Stempel (24) und die Wand relativ zu einander bewegt werden, wobei der Stempel (24) so geformt ist, daß während der fortgesetzten relativen Bewegung zwischen dem Stempel (24) und der Wand das Material um das Loch (30) fortschreitend in radialer Richtung zu einem ringförmigen Kragen hinein gedehnt wird; und 30

d) die Vorrichtung Mittel zum Einführen von Flüssigkeit unter hohem Druck in den ringförmigen Teil (10) umfaßt.

8. Vorrichtung nach Anspruch 7, dadurch gekennzeichnet, daß die Haltebacken (14, 16) eine Verformungskammer (18, 20) bilden, deren Dimensionen größer sind als jene des entsprechenden Abschnittes des rohrförmigen Teiles (10) vor dem Einführen der Druckflüssigkeit in den Teil selbst, so daß das Einführen der Flüssigkeit in den rohrförmigen Teil das radiale Dehnen des Abschnittes dieses Teiles innerhalb der Kammer (18, 20) und das Eindringen des Stempels (24) in die Wand des Teiles (10) bewirkt. 35

#### Revendications

1. Procédé de fixation d'un insert tubulaire de renforcement (12) à une structure métallique tubulaire (10), comprenant la formation d'un trou (30) dans la paroi de la structure tubulaire (10) par déformation vers l'intérieur d'une partie de la paroi afin que la partie déformée de paroi forme un collier annulaire (32), caractérisé en ce qu'il comprend les étapes suivantes : 40
  - l'emmanchement à force d'une partie d'extrémité (26) de l'insert tubulaire (12) dans le collier (32), et
  - l'introduction d'un liquide à haute pression dans la structure tubulaire (10) afin que le collier soit comprimé contre la partie d'extrémité (26) de l'insert tubulaire (12). 45
2. Procédé selon la revendication 1, caractérisé en ce que le trou (30) et le collier (32) sont formés par l'introduction à force d'un poinçon (24) dans la paroi de la structure tubulaire (10). 50
3. Procédé selon la revendication 2, caractérisé en ce qu'il comporte en outre l'étape de dilatation radiale d'une partie de la structure tubulaire (10) d'une manière qui correspond au point d'ancrage de l'insert (12) sous l'effet de l'introduction du liquide sous pression dans la structure tubulaire (10), l'introduction du poinçon (24) dans la paroi de la structure tubulaire (10) étant provoquée par la dilatation radiale de la paroi. 55
4. Procédé selon la revendication 2 ou la revendication 3, caractérisé en ce que l'insert tubulaire (12) est placé sur le poinçon (24) avant l'étape d'introduction du poinçon (24) dans la paroi de la structure tubulaire (10), le poinçon (24) ayant une extrémité pointue qui dépasse au-delà de l'extrémité de l'insert (12).
5. Procédé selon la revendication 1, caractérisé en ce

que ladite partie d'extrémité (26) de l'insert (12) est conique.

6. Procédé selon la revendication 1, caractérisé en ce que l'insert tubulaire (12) a une gorge annulaire (28) sur laquelle le collier (32) est fermé pendant sa compression contre la partie (26) d'extrémité de l'insert (12). 5
7. Appareil de fixation d'un insert tubulaire (12) de renforcement sur une structure tubulaire métallique (10), dans lequel : 10
  - a) l'appareil comprend deux matrices (14, 16) destinées au serrage de la structure tubulaire (10) entre elles, 15
  - b) l'une des matrices (16) a une cavité (22) dans sa paroi de base, un poinçon (24) étant fixé dans la cavité (22), son extrémité libre dépassant au-delà de la paroi de base, une cavité cylindrique qui peut loger l'insert de renforcement (12) étant délimitée entre le poinçon (24) et la paroi de la cavité (22), 20
  - c) le poinçon (24) comporte une partie pointue à son extrémité libre, la partie pointue convenant à l'ouverture d'un trou (30) dans la paroi de la structure tubulaire (10) et déformant vers l'intérieur la partie de paroi qui est ouverte lorsque le poinçon (24) et la paroi sont déplacés mutuellement, le poinçon (24) ayant une configuration telle que, lors de la poursuite du déplacement relatif du poinçon (24) et de la paroi, le matériau entourant le trou (30) se dilate progressivement en direction radiale dans un collier annulaire, et 25 30 35
  - d) l'appareil comprend un dispositif d'introduction d'un liquide à haute pression dans la structure tubulaire (10). 40
8. Appareil selon la revendication 7, caractérisé en ce que les matrices (14, 16) délimitent une chambre de déformation (18, 20) dont les dimensions sont plus grandes que celles de la partie correspondante de la structure tubulaire (10) avant l'introduction du liquide sous pression dans sa structure si bien que l'introduction du liquide dans la structure tubulaire provoque une dilatation radiale de la partie de cette structure dans cette chambre (18, 20) et la pénétration du poinçon (24) dans la paroi de la structure (10). 45 50

